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Abstract: Consumer-centric energy markets and distribution grid tariff reform: A review of the current debate in Denmark, Germany and the EU

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From distribution to interaction grid

**Fundamental questions on the role of and tariff design in distribution networks of
100% renewable energy systems**

A framework for evaluating grid tariff policy proposals?

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Smart Energy Systems conference

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Background

As generation costs of renewables are falling and prosumers are on the rise, policy debates are changing:

- towards post-feed-in-tarif market designs
- towards flexibility incentives
- ... and towards grid tariff reform

Agenda (with spoiler)

1. Ask two fundamental questions (in order to establish an analytical lens):
 - 1) What is the role of a grid (a), and what is part of it? (b)
 - 2) Who pays, and according to what principle?
2. Evaluate current *regulatory principles* through this lens
3. Evaluate current *grid reform proposals* through this lens
4. Conclude
 - 1) Grid reform cannot sensibly be discussed without a new understanding of the role of the grid (=interaction grid)
 - 2) Grid reforms cannot sensibly be designed independently of (flexibility) market reforms
5. Outlook: Who owns data?

1: Ask fundamental questions

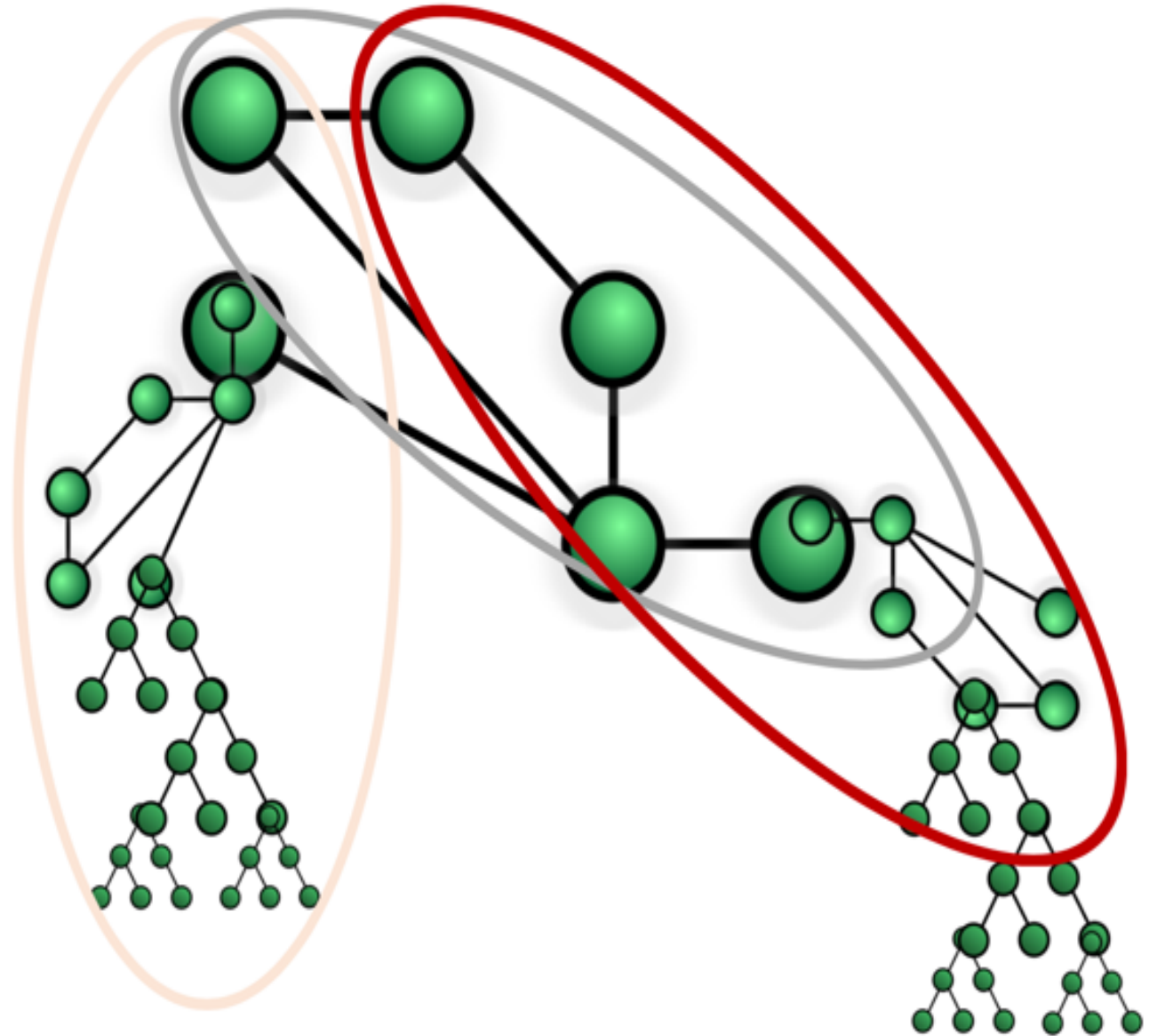
- 1) What is the role of a grid (a), and what is part of it? (b)
- 2) Who pays, and according to what principle?

1. a): What is/was the role of a grid?

Figure 2: Ideal-type illustration of centrally organized electricity network following the waterfall principle: A consumer pays for all voltage levels from their connection point at low voltage (beige), medium voltage (red) and high voltage (grey)

Source: Wikimedia Commons (2006, 2008) and own illustration

Zentral organisiertes Stromsystem:
Teilvermaschtes Übertragungsnetz mit
hierarchischem Verteilnetz
Beige = Strombezug bei
Niederspannungsanschluss
Rot = Strombezug bei Mittelspannungsanschluss
Grau = Strombezug bei
Hochspannungsanschluss



Tomorrow:

Figure 3: Decentrally organized electricity grid based on ‚subsidiarity principle‘.

Teilvermaschtes Übertragungsnetz mit teilvermaschtem Verteilnetz

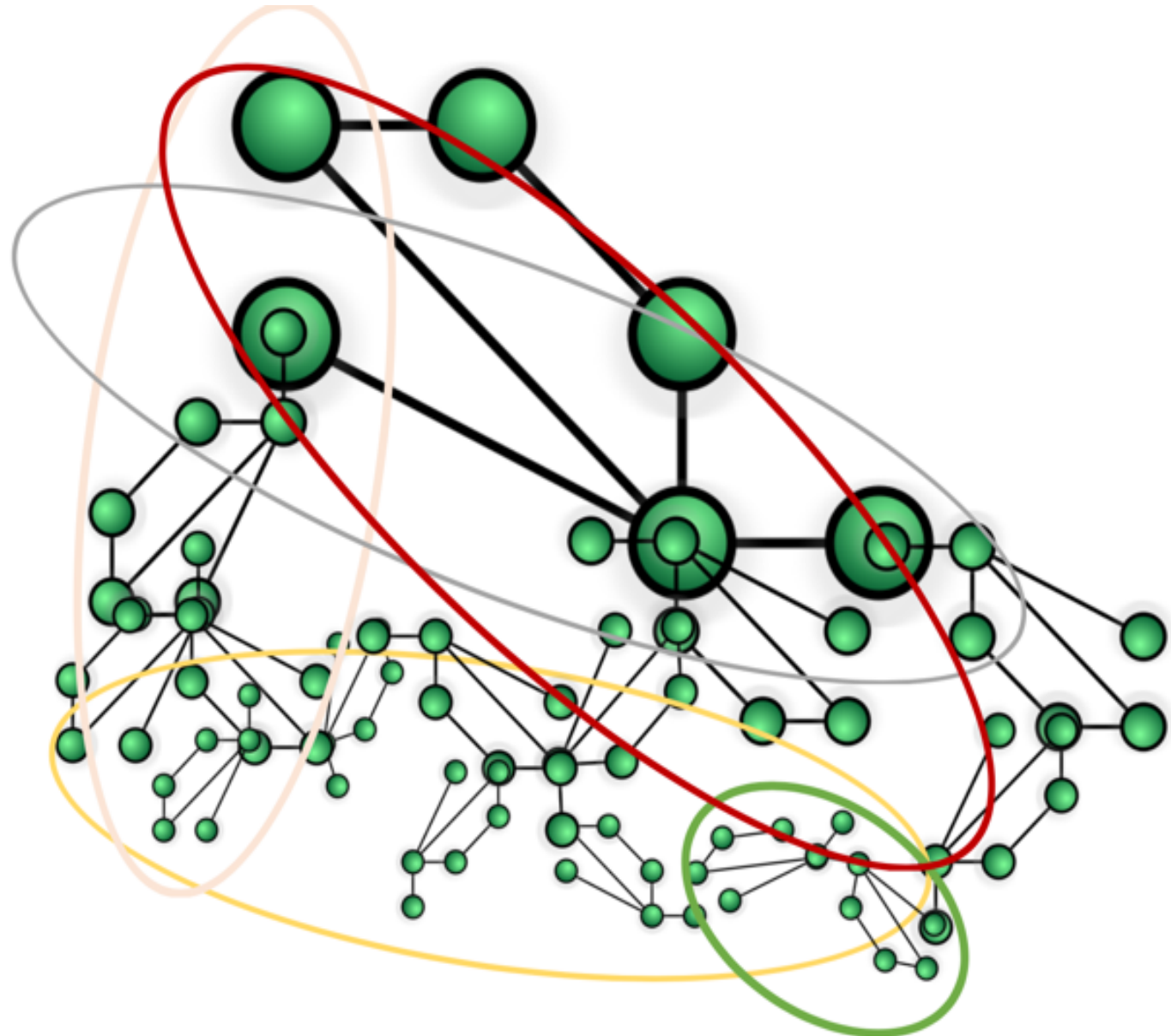
Beige = Strombezug über alle Netzebenen bei Niederspannungsanschluss

Rot = Strombezug bei Mittelspannungsanschluss

Grau = Strombezug bei Hochspannungsanschluss

Grün = Strombezug innerhalb des Niederspannungsnetzes

Gelb = Strombezug innerhalb des Nieder- und Mittelspannungsnetzes



Partial conclusion 1.a.)

- The role of the grid is to facilitate the transition to a renewables-based smart energy system

1. b.): What is part of the grid?

- If the grid and its operation is defined as a natural monopoly, then, by definition, only natural monopoly activities are part of the grid

Partial conclusion 1.b)

- Both today and tomorrow: Natural monopoly

2. Who pays, how much and according to what principles? Illustration of EU consumer electricity prices:

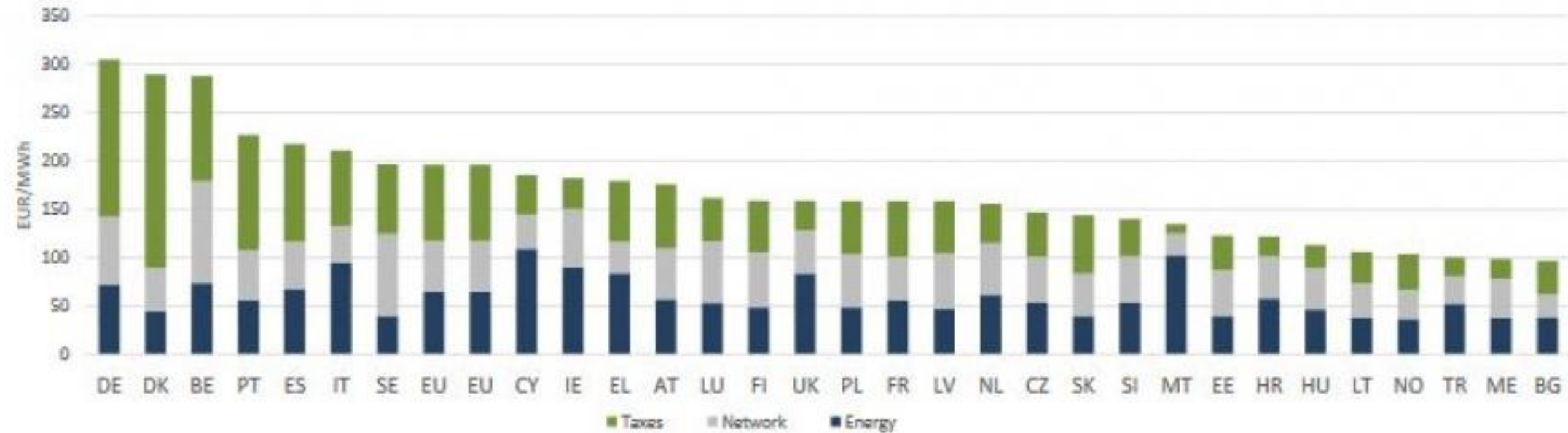


Figure 2 — Household electricity prices in 2017 (most representative consumption band) — Source: DG ENER in-house data collection³

Illustration of EU industry electricity prices:

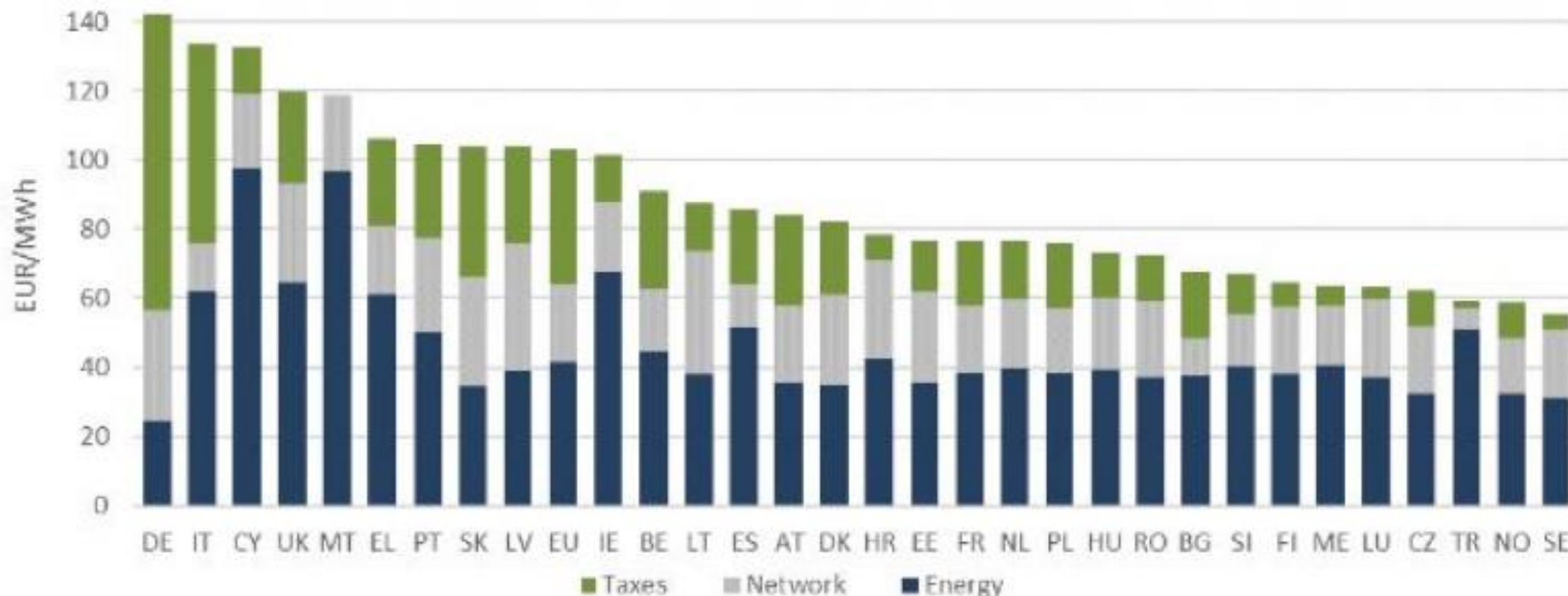


Figure 3 — Industrial electricity prices in 2017 — Source: DG ENER in-house data collection

Break-down of current Danish consumer prices

Figure 1: Composition of household electricity price in Denmark, July 2019.
Sources:: 50 Hertz Transmission u. a. 2019; Dansk Energi 2018; Ørsted.dk 2019; Vattenfall Europe 2019; own calculations

| Electricity price components households, July 2019 | DK: Radius & Ørsted | |
|----------------------------------------------------|---------------------------------|--------------------------------|
| | DKK | EUR |
| Wholesale electricity | 33,45 øre/kWh | 4,49 cent/kWh |
| PSO-levy | 0,0 øre/ kWh | 0 cent/kWh |
| Subscription | 31,2 DKK/ Month | 4,19EUR/Month |
| Sum electricity charges excl. VAT | 4,49 cent/kWh + 4,19 EUR/Month | |
| Grid subscription | 25 DKK/Month | 3,36EUR/Month |
| Local grid charge | 30,01 øre/kWh | 4,03 cent/kWh |
| | From 2020: 3,48 /8,97 cent/kWh | |
| Regional Grid charge | (not applicable in Radius grid) | |
| Transmission charge | 4,4 øre / kWh | 0,59 cent/kWh |
| System charge | 3,6 øre / kWh | 0,48 cent/kWh |
| Balancing charge | 0,13 øre / kWh | 0,017 cent/kWh |
| Regulation authority charge | 0,13 øre / kWh | 0,017 cent/kWh |
| Sum of grid charges excl. VAT | 5,13 cent/kWh + 3,36 EUR/Month | |
| Electricity tax | 91,00 øre/kWh | 12,2 cent/kWh |
| Value-added tax | 25 % | 5,46 cent/kWh + 1,89 EUR/Month |
| Sum Taxes +VAT | 17,66 cent/kWh + 1,89 EUR/Month | |
| Total | 27,28 cent/kWh + 9,44 EUR/Month | |

A small dictionary of grid principles (*not* literal translations)

| ENG | DK | DE | Definition |
|-------------------------------------------------------------------|--------------------------------|---------------------------------------|-------------------------------------------------------------------------------------|
| „cost orientation principle“ | Omkostningsægthed | Verursacherprinzip | Currently by definition mostly a consumer, not a producer |
| „Waterfall principle“ | vandfaldsprincip | <i>Kostenwälzungsprinzip</i> | The highest voltage level is the assumed level of generation. |
| „Stamp principle“ | | „Eine Briefmarke für ganz Europa“ | Grid use costs the same no matter where electricity comes from |
| Revenue cap regulation | Indtægtsramme-regulering | Anreizregulierung | Today, allows for supernormal profits |
| Frequently used terms without exact equivalents across languages: | | | |
| Not-for-profit ownership | hvile-i-sig-selv, forbrugereje | Daseinsvorsorge Rekommunalisierung | These are terms used when not-for-profit ownership is being practiced or considered |

Evaluation current grid tariff principles

| | Question 2: Who pays for grids, how much, and according to which principle? | | | |
|------------------------------------------------------|---------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | (1) Waterfall principle | (2) Cost orientation principle | (2) Revenue cap regulation | (4) „Stamp principle“ |
| 1a: Does it facilitate a smart energy system? | No. The highest voltage level is the default level of origin by definition. | No. It seems that by definition, the „cause“ of costs can only be newcomers to the system, that is, new producers or new prosumers | No. Flexibilities cannot be bought, but only be built. This leads to a “copper only” strategy, | No, because local production is not „rewarded“ / lower transportation costs of combined local production and consumption is not reflected. Combination of this principle with the (1) discriminates producers at distribution level |
| 1b: Is it a natural monopoly activity? | Yes, but it leads to over-investment in transmission capacity and underinvestment at distribution level | Yes, but it is inherently conservative because of the built-in path dependence | Yes, but the revenue cap regulation allows for supernormal profits | Yes, but it can be considered as a form of consumer subsidy for remote production that leads to expansion of the natural monopoly. |

Evaluate exemplary policy proposals

| | Question 2: Who pays for grids, how much, and according to which principle? Examples of policy proposals | | | |
|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| | Time (grid status) differentiated grid tariffs | distance differentiation (e.g. s from your neighbor than from offshore) | Capacity vs. Energy (usually: Increasing the capacity price component compared to todays kWh-based charge | Differentiation according to security of supply (remote control of supply, „netprodukt“)“) |
| 1a: Does it facilitate a smart energy system? | They can, but do not necessarily. What if grids are clogged with coal power? | Yes (it is a revision of the waterfall principle) | Only in combination with a flexibility market. Also, flat rate has the social downside (DK: „vender den tunge ende nedad“) | Yes, if the control parameters are set to maximise renewables uptake in the grid |
| 1b: Is it a natural monopoly activity? | No. Could be provided via flexibility market | Yes. Paying less for grid use for electricity from your neighbor is a natural monopoly activity | Yes. | No. Could be provided via a flexibility market |

local flexibility markets are an alternative to grid tariff reform

4. Conclusions

- **Re-interpreting** the **cost-orientation principle** as a principle of lowest system costs, reflecting a smart energy system thinking
- **Replacing** the **waterfall (and stamp) principles** by a **subsidiarity principle**
- **Unbundling** monopoly and market domains at last by **establishing local flexibility markets**
- **Redesigning** the **revenue cap regulation** (indtægtrammeregulering) can make the network operator a buyer of flexibilities, serving both as an incentive to the non-discriminatory and neutral role of the network monopoly and to make consumers more flexible through aggregators, thereby creating the basis for local flexibility markets
- **Departing** from the **copper plate assumption** in electricity market design by implementing „electricity regions“
- **Incentivizing** **PPA's (power purchase agreements)** for a a post feed-in era

...can lead to successful energy policy reforms on the path to 100 % renewable smart energy systems

5. Outlook: More on power and ownership

More on grid ownership:

→ Hvelplund, Frede, and Søren Djørup. 2019. “Consumer Ownership, Natural Monopolies and Transition to 100% Renewable Energy Systems.” *Energy* 181: 440–49.

<https://doi.org/10.1016/j.energy.2019.05.058>.

More on data ownership:

Intelligent meters do not only shift loads, but also power structures in energy systems

→ Hasberg, Kirsten Sophie. 2019. From Energopower to Infopower: Smart Energy Systems as Co-Constituted by Energy & Information Systems.

The introduction of hourly consumer electricity prices and time-varying network charges in Denmark (flexafregning) through the mandatory installation of smart meters gives distribution system operators data sovereignty over consumer data, which extends their monopoly position beyond the natural monopoly of the physical grid.

Please help me find...

- Incoherent arguments
- Unclear points
- Logical fallacies

Thank you!

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